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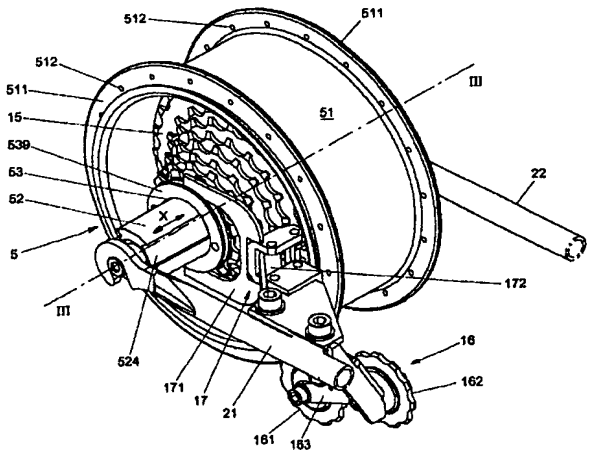
(54) Title: HUB ASSEMBLY WITH AXIALLY MOVABLE DRIVE WHEEL CARRIER



(57) Abstract: A hub assembly has a hub body (51) for carrying a rim support, a mounting structure (54) fixedly mountable to a bicycle fork and a bearing structure (57) between the hub body (51) and the mounting structure (54). A drive sleeve (52) is suspended for rotation about the main axis and coupled to the hub body (51) for driving rotation of the hub body about the main axis. A drive wheel carrier (53) is coupled to the drive sleeve for driving rotation of the drive sleeve (52). A bearing member (56) between the drive wheel carrier (53) and the drive sleeve (52) axially guides the drive wheel carrier (53) along the drive sleeve (52). At least one projection (53; 520-523; 531-533; 534-536) projects between the drive wheel carrier (53) and the drive sleeve (52). The bearing member (56) includes a bearing part circulatable about the projection (53; 520-523;531-533;534-536).

WO 03/064242 A1

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Title: Hub assembly with axially movable drive wheel carrier

FIELD AND BACKGROUND OF THE INVENTION

The invention relates to a hub assembly according to the introductory portion of claim 1 and to a hub assembly according to the introductory portion of claim 8. The invention further relates to a gearing assembly, a bicycle wheel and a bicycle comprising such a hub assembly.

A hub assembly of the above-identified type is known from UK patent application 2 280 002. In this known assembly, a tubular end extends axially from the hub body. About this tubular end and coaxial therewith, a drive sleeve is arranged. The drive sleeve is coupled to the hub body by a one-way clutch. A sprocket wheel carrier carrying drive wheels in the form of sprocket wheels is arranged coaxial with and around the drive sleeve and capable of axial sliding movement. For guiding the axial movement of the drive wheel carrier, three sets of axially aligned ball bearings are spaced apart around the inner periphery of the outer part of the sprocket wheel carrier. Each set comprises four axially aligned spaced ball bearings received in generally hemispherical recesses in the inner cylindrical surface of the drive wheel carrier. The four aligned ball bearings in each set engage in a corresponding axial groove formed in the drive sleeve. This bearing arrangement allows the sprocket wheel carrier, carrying the sprocket wheels, to slide axially in relation to the drive sleeve but prevent rotation of the sprocket wheel carrier about the drive sleeve so that rotation of the sprocket wheel carrier can be transferred to the drive sleeve to be transferred to the hub body.

Compared with conventional hub assemblies in which the sprocket wheels are in an axially fixed position, the axial movability of the sprocket wheel carrier allows to keep the chain better in alignment with the front chain wheel when the chain runs over sprocket wheels which would normally not be in alignment with the front chain wheel. Another advantage of such a hub is that lateral displacement of the chain when switching through the gears is

almost completely eliminated, so a chain guard enveloping the chain of practicable dimensions can be employed.

However, a disadvantage of this known hub assembly is that axial movement of the sprocket wheel carrier requires a large force because of friction between the sprocket wheel carrier and the drive sleeve, especially when at the same time a driving couple is exerted by the sprocket wheel carrier. Other disadvantages of this known hub assembly are that the hub assembly is relatively wide, that the drive sleeve has a large diameter so that the sprocket wheel carrier is not suitable for carrying standard sprocket wheels and/or very little room for guide structures for axially guiding the sprocket wheel carrier is available, and that during coasting relatively much friction between the drive sleeve and the sprocket wheel carrier occurs.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a hub assembly of simple design in which the axial movement of the sprocket wheel carrier requires less force.

According to the present invention, this object is achieved by providing a hub assembly according to claim 1. The bearing member or members reduce friction between the drive wheel carrier and the drive sleeve while circulation of the bearing part or parts about the projection ensures that the bearing part or parts remain effective throughout the axial range in which the bearing is operative for guiding the drive wheel carrier axially along the drive sleeve.

It is another object of the present invention to reduce the axial size of the hub assembly, to reduce the diameter of the drive sleeve and to reduce friction when coasting. According to the present invention, this object is achieved by providing a hub assembly according to claim 8. Because bearings are provided between the hub body and the drive sleeve and between the drive sleeve and the mounting structure, bearing loads can be transferred between the hub body and the mounting structure through the drive sleeve. This, in

turn allows the drive sleeve to be located inside the hub body and to extend relatively far inside the hub body. Moreover, the drive sleeve inner bearing rotatably suspends the drive sleeve relative to the mounting structure, so that the hub body does not need to project inside the drive sleeve to support the drive sleeve and thereby friction between the drive sleeve and the hub body during coasting is avoided. The absence of the hub body inside the drive sleeve further allows the drive sleeve to be of relatively small diameter, so that the drive wheel carrier can be of a small diameter and/or room for axial guide structures between the drive wheel carrier and the drive sleeve is obtained. Because of the latter, the provision of bearings between the hub body and the drive sleeve and between the drive sleeve and the mounting structure is particularly advantageous in a hub assembly according to claim 1.

The invention can also be embodied in a gearing assembly according to claim 9, a bicycle wheel according to claim 10 or a bicycle according to claim 11.

Particular embodiments of the invention are set forth in the dependent claims. Further aspects, effects and details of the invention will be described with reference to an exemplary embodiment shown in the drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a side view of a bicycle equipped with an example of a hub assembly according to the invention,

Fig. 2 is a perspective view of an exemplary embodiment of a hub assembly according to the invention mounted on a bicycle,

Fig. 3 is a cross-sectional view along a plane through the line III-III in Fig. 2,

Fig. 4 is a perspective schematic view of a drive wheel carrier and a drive sleeve of the hub assembly according to Figs. 2 and 3,

Fig. 5 is a perspective schematic view of a drive sleeve of the hub assembly according to Figs. 2-4,

Fig. 6 is an enlarged schematic cross-sectional view of a drive wheel carrier and a drive sleeve with a rolling bearing of the hub assembly according to Figs. 2-5, and

Fig. 7-9 are schematic cross-sectional views of alternative exemplary arrangements of a drive wheel carrier, bearings and a drive sleeve of a hub assembly according to the invention.

DETAILED DESCRIPTION

In the description, corresponding parts of different embodiments are designated by mutually identical reference numbers.

The bicycle 1 shown in Fig, 1 has a frame 2 with a front fork 3 movably coupled thereto, a rear wheel 4 rotatably suspended in a rear suspension of the frame 2. The rear wheel 4 has a rear hub assembly 5. A front wheel 6 is rotatably mounted in the front fork 3 and has a front hub assembly 7. A seat 8 is adjustably coupled to the frame 2. A handlebar 9 is coupled to the front fork 3 for steering the front wheel 6. A drive train 10 is provided for propelling the bicycle 1. The drive train 10 includes a front set of chain wheels 11 rotatably mounted to the frame 2 via a bottom bracket (not shown). A pair of crank arms 12 with pedals 13 are connected to the chain wheels 11 over which a drive chain 14 for driving rear drive wheels 15 runs. Sprocket wheels 15 form the rear drive wheels and are mounted onto the rear hub assembly 5. Between the chain wheels 11 and the rear sprocket wheels 15 a lower section of the drive chain 14 extends through a chain tensioner 16 which is mounted to a bottom fork arm 21 of the frame 2.

In Figs. 2-6 the rear hub assembly 5 and portions thereof are shown in more detail. The hub assembly 5 is shown in mounted condition with its main shaft 54 forming the mounting structure mounted between rear fork arms 21, 22 of the frame 2. The hub assembly 5 comprises a hub body 51, a drive sleeve 52 and a sprocket wheel carrier 53. In the present example, the hub body 51 is substantially cup-shaped and provided on its outside with flanges 511 at the

axial ends. The flanges 511 are provided with holes 512 for mounting spokes. The hub body can have many forms and for instance, also be integrated in the rear wheel, for instance as integral part of a wheel having a cast light alloy or composite integral rim carrying structure and rim, or be adapted to be attached to a disk shaped rim carrying structure.

The cup-shaped hub body 51 is adapted for partially accommodating the sprocket wheel carrier 53 and the set of sprocket wheels 15 carried thereby. The sprocket wheel carrier 53 is of a substantially cylindrical shape. The hub body 51 and the sprocket wheel carrier 53 are positioned in a substantially coaxially with respect to each other. In the present example, the sprocket wheel set 15 is mounted on the outside of the sprocket wheel carrier 53. Other types of drive wheels may also be used, for example one or more drive wheels for co-operation with a toothed, flat or V-shaped drive belt, a conically shaped drive wheel or a pair of co-operating conical drive wheels each mounted on a separately moveable drive wheel carrier.

The sprocket wheel carrier 53 is arranged to the outside of a drive sleeve 52. The drive sleeve 52 is a substantially a cylindrical member and the longitudinal axis of the sprocket wheel carrier 53 and the drive sleeve 52 are substantially coincident. The drive sleeve 52 is provided with an axially extending recess 524. As is schematically shown in Fig. 4, disk-shaped bearing members 56, are provided between the sprocket wheel carrier 53 and the support 52. The disk-shaped bearing members 56 are each mounted to a projection 531 and each have outer bearing parts in the form of balls 563 and a bearing ring 562 rotatable about a central axis A of that projection, which extends perpendicularly from the sprocket wheel carrier 53. As shown in Fig. 5, the disk-shaped bearing members 56 are situated in the groove-shaped recess 524.

The sprocket wheel carrier 53 is movable with respect to the drive sleeve 52 in a longitudinal or axial direction of the sprocket wheel carrier 53 and the drive sleeve 52, as is indicated with arrow X. The movement of the sprocket

wheel carrier 53 is guided by the bearing members mounted to the inside thereof, the outer bearing parts 562 of the bearings rolling along sidewalls 525 of the recess 524. The provision of bearing members having circulating bearing parts between the sprocket wheel carrier 53 and the drive sleeve 52 results in a low friction during axial displacement of the sprocket wheel carrier 53 along the sleeve 52 and the circulation of the bearing parts 562, 563 prevents the bearing parts 562, 563 from being blocked during movement of the sprocket wheel carrier 53 throughout its operating range. In the present example, the bearings 56 are of a circular shape, which is advantageous in that standard ball bearings, roller bearings or slide bearings can be used and the outer part of the bearing can be of an essentially rigid construction. However, it is also possible to provide a circulating bearing of for example an elongate shape, for instance a bearing of which the outer bearing part is formed by a flexible endless, for instance caterpillar-like belt and in which rollers, such as balls, roll between the circulating endless belt and an essentially rigid inner track arranged on the projection.

In the present example, axial movement of the member 56 in the direction indicated with arrow X results in the outer ring 562 of the disk-shaped bearing members 56 rolling along either one of the walls 525 and thereby rotating about the central axis A, for example in the direction indicated with arrow R in Fig. 5. Since bearing members 56 are roller bearings, and more particularly ball bearings, as are shown in Figs 3 and 5–8, friction during guiding axial displacement of the sprocket wheel carrier 53 along the drive sleeve 52 is particularly low.

As best seen in Fig. 2, a shifter 17 is provided for controlling the axial position of the sprocket wheel carrier 53. The shifter 17 is mounted to the bottom arm 21 of the rear fork and engages a groove in a flange 539 on the sprocket wheel carrier 53. The flange 539 is located on the outside of the sprocket wheels 15 which is closest to the rear fork arm 21. The shifter 17 comprises an engaging member 171 which is translatably suspended with

respect to the fork arm 21 by means of a parallelogram 172 between the arm 21 and the engaging member 171. In this example, the emngaging member is formed by a fork of which the spacing between the teeth corresponds to the diameter of the groove in the flange 539. The arm 21 also carries a chain tensioner 16. The tensioner 16 has two toothed wheels 161,162 spaced apart on a beam 163. The beam 163 is pivotable about an axis which is essentially parallel to the main axis of the hub 5. In operation, a chain extends over the wheel 162 and under the wheel 161. Pivoting of the beam 163 results in an increase or decrease of the length of the chain and hence of the tension in the chain. The movement of the beam is spring biased, the spring resiliently urging the beam in a pivoting sense tensioning the chain.

As best seen in Fig. 3, the drive sleeve 52 is rotatably mounted on the axis 54 by means of a ball bearing 55 and a needle bearing 59. The hub body 51 is rotatably supported to the axis 54 by means of a ball bearing 57 and to the drive sleeve 52 by means of needle bearings 60, 61. Because bearings 59-61 are provided between the hub body 51 and the drive sleeve 52 and between the drive sleeve 52 and shaft 54, bearing loads can be transferred between the hub body 51 and the mounting structure 54 via the drive sleeve 52. This, in turn allows the drive sleeve 52 to extend relatively far inside the hub body 51. Moreover, the bearing 59 between the drive sleeve 52 and the shaft 54 rotatably suspends the drive sleeve 52 relative to the shaft 54, so that the hub body 51 does not need to project inside the drive sleeve 52 to support the drive sleeve 52 and thereby friction between the drive sleeve 52 and the hub body 51 during coasting is prevented. The absence of the hub body 51 inside the drive sleeve 52 further allows the drive sleeve 52 to be of a relatively small diameter, so that the sprocket wheel carrier 53 can be of a small diameter (for instance of a diameter accepting generally available standard sprocket wheel cassettes) and/or room for the axial guide structures 56 between the sprocket wheel carrier 53 and the drive sleeve 52 is obtained. Because of the latter effect, the provision of bearings 59-61 between the hub body 51 and the drive sleeve 52

and between the drive sleeve 52 and the mounting structure 54 is particularly advantageous in a hub assembly with circulating bearings 56 axially guiding the sprocket wheel carrier 53 relative to the drive sleeve 52.

Between the drive sleeve 52 and the hub body 51 a freewheel clutch 58 is situated. The freewheel clutch 58 allows the hub body 51 to rotate in one (forward) sense of rotation relative to the drive sleeve 52 only, so that if the drive sleeve 52 is rotated in forward sense, the hub body 51, and thereby the whole wheel, is entrained. As such, freewheel clutches are well known in the art, so the freewheel clutch 58 as such is not described in detail. In Fig. 3, the freewheel clutch 58 is situated on the side of the central plane of rotation of the hub 5 opposite the side on which the chain extends about the sprocket wheels. This allows the sprocket wheel carrier 53 to shift relatively far into the hub body 51, so that the axial dimensions of the hub 5 are reduced.

In Fig. 6 a cross-section of one of the axial guide structures is shown in more detail. The rolling bearing 56 is rotatably fixed to the sprocket wheel carrier 53 via a projection in the form of a pin 531 projecting from the sprocket wheel carrier 53 and is located in the recess 524 of the drive sleeve 52. The bearing 56 is composed of an inner ring 561 placed coaxially clamped about the pin 531, an outer ring 562 and balls 563 retained between the inner ring 561 and the outer ring 562.

As can be seen in Figs. 3 and 4, the bearings 56 are arranged in sets each forming a row parallel to the main axis of the hub 5. It is preferred that a plurality of bearings or sets of bearings 56 is provided, and in particular it is preferred that the bearings or sets of bearings are located in at least three circumferentially distributed positions, so that also reactive forces are transferred via the bearings between the sprocket wheel carrier 53 and the drive sleeve 52. For example, the bearings 56 can be placed in sets of three bearings as shown in Figs. 3 and 4.

As is shown in Figs.7-9, the central axis A of the bearings of each set may make an angle A with respect to the bearing members of the other sets. In

the example shown in Fig. 7, the angle between the central axes A of the bearings 56 is 120°, the central axes A extend radially relative to the main axis of the hub 5, and three sets of bearings are provided. This allows to also transfer the transversal forces for keeping the sprocket wheel carrier 53 in coaxial position relative to the drive sleeve 52 via the circumferences of the bearings 56 only, so that any direct friction between the drive sleeve 52 and the sprocket wheel carrier 53 can be prevented. In the example shown in Fig. 9, four sets of bearings 56 are provided, The sets are oriented at angles of 90° with respect to each other. The provision of more than three circumferentially distributed bearings or sets of bearings is advantageous for reducing the load per bearing, so that relatively small bearings can be used which can be accommodated in a space which is relatively thin in radial direction. However, it is likewise possible to arrange projections 534-536 such that the bearings 56 are arranged with their axis A in a non-radial direction, as is shown in Fig. 8. Such orientations of the axes A of the bearings can for instance be advantageous for providing additional width for the tracks 537 against which the outer bearing shells are pressed when a driving torque is transferred from the sprocket wheel carrier 53 to the drive sleeve 52. Another advantage of such an orientation can be that the tracks against which the outer bearing shells are pressed when a driving torque is transferred can be oriented in a plane intersecting the main axis of the hub 5, so that the torque is transferred by forces perpendicular to the axes A and axial loading of the bearings is prevented or at least reduced.

The bearings 56 may be rotatably mounted to the sprocket wheel carrier 53, for example by means of a pin 531-333 as is shown in Fig. 7. The drive sleeve may then be provided with a recess. The bearing members may also be mounted to the drive sleeve 52, for example with pins 520-523 and be positioned in a recess in the sprocket wheel carrier, as is shown in Fig. 9. Mounting the bearings 56 in fixed positions relative to the sprocket wheel carrier does however provide the advantage, that relatively few bearings are

required because the sprocket wheel carrier 53 which is axially moveable along the drive sleeve 52 is of a smaller axial size than the drive sleeve 52. Moreover, if the bearing 56 are mounted to the sprocket wheel carrier 53, the bearings 56 are shielded by the sprocket wheel carrier in any position of the sprocket wheel carrier 53, since the sprocket wheel carrier 53 which envelops the bearings 56 moves along the drive sleeve 52 with the sprocket wheel carrier 53.

Within the framework of the present invention many other embodiments and applications than what is described above are conceivable. The hub according to the present invention can for instance also be used as a part of a vehicle with a motor to assist driving the vehicle by muscle power or to form the only means of driving the vehicle. The vehicle can also have more than two wheels. If two essentially coaxial wheels are driven, the hub assembly may comprise two spaced apart hub bodies and drive shafts between the drive sleeve and the hub bodies.

Claims

1. A hub assembly comprising:

a hub body (51) for carrying a rim support structure,

a mounting structure (54) fixedly mountable to a bicycle fork,

a bearing structure (57) between the hub body (51) and the mounting structure (54) suspending the hub body (51) for rotation relative to the mounting structure (54) about a main axis of rotation,

a drive sleeve (52) suspended for rotation about the main axis and coupled to the hub body (51) for driving rotation of the hub body about the main axis,

a drive wheel carrier (53) for carrying drive wheels and coupled to the drive sleeve for driving rotation of the drive sleeve (52), and

a bearing member (56) between the drive wheel carrier (53) and the drive sleeve (52) axially guiding the drive wheel carrier (53) along the drive sleeve (52) and at least partially arranged in an axial groove in one of the drive wheel carrier (53) and the drive sleeve (52),

characterized by at least one projection (53; 520-523; 531-533; 534-536) projecting from the other one of the drive wheel carrier (53) and the drive sleeve (52) towards the one of the drive wheel carrier (53) and the drive sleeve (52), the bearing member (56) including at least one bearing part circulatable about the projection(53; 520-523; 531-533; 534-536).

2. A hub assembly according to claim 1, wherein the bearing member (56) is a circular bearing member (56) suspended coaxially with the projection (53; 520-523; 531-533; 534-536) around which it extends.

3. A hub assembly according to claim 1 or 2, wherein the bearing member (56) comprises rollers retained in an outer circulatable bearing part.

4. A hub assembly according to any one of the preceding claims, including at least three sets of at least one bearing member (56), a projection (53; 520-523; 531-533; 534-536) and an axial groove, the sets being circumferentially distributed about the main axis.

5. A hub assembly according to any one of the preceding claims, wherein the projections (53; 531-533; 534-536) project from the drive wheel carrier (53).

6. A hub assembly according to any one of the preceding claims, wherein the projections (53; 520-523; 531-533; 534-536) project perpendicular to the main axis.

7. A hub assembly according to any one of the preceding claims, wherein the projections (53; 520-523; 531-533) project radially towards or away from the main axis.

8. A hub assembly comprising:

a hub body (51) for carrying a rim support structure,

a mounting structure (54) fixedly mountable to a bicycle fork,

a bearing structure (57) between the hub body (51) and the mounting structure (54) suspending the hub body (51) for rotation relative to the mounting structure (54) about a main axis of rotation,

a drive sleeve (52) suspended for rotation about the main axis and coupled to the hub body (51) for driving rotation of the hub body about the main axis,

a drive wheel carrier (53) for carrying drive wheels and coupled to the drive sleeve for driving rotation of the drive sleeve (52),

a bearing member (56) between the drive wheel carrier (53) and the drive sleeve (52) axially guiding the drive wheel carrier (53) along the drive sleeve (52) and at least partially arranged in an axial groove ( ) in one of the drive wheel carrier (53) and the drive sleeve (52), and

a freewheel coupling between the drive sleeve (52) and the hub body (51) **characterized in that**

the bearing structure (57) between the hub body (51) and the mounting structure (54) includes a first bearing (60, 61) between the hub body (51) and the drive sleeve (52) and a second bearing (59) between the drive sleeve (52) and the mounting structure (54).

9. A gearing assembly, comprising a hub assembly according to any one of the preceding claims, and a gear change mechanism (17) for axially moving the drive wheel carrier (53) with respect to the drive sleeve (52).

10. A bicycle wheel comprising a hub assembly (5) according to any one of the claims 1-8.

11 A bicycle comprising a hub assembly (5) according to any one of the preceding claims 1-8.

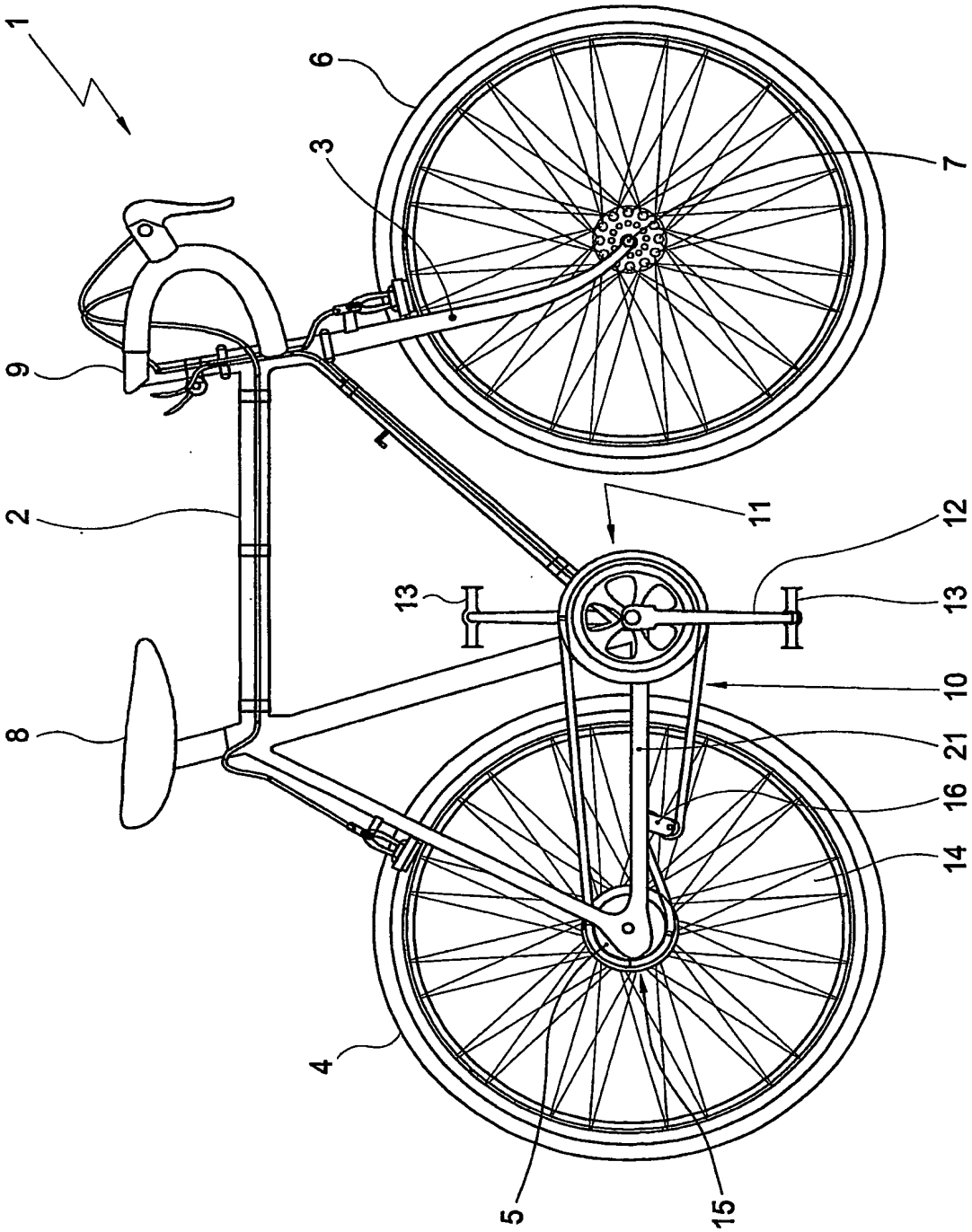


Fig. 1

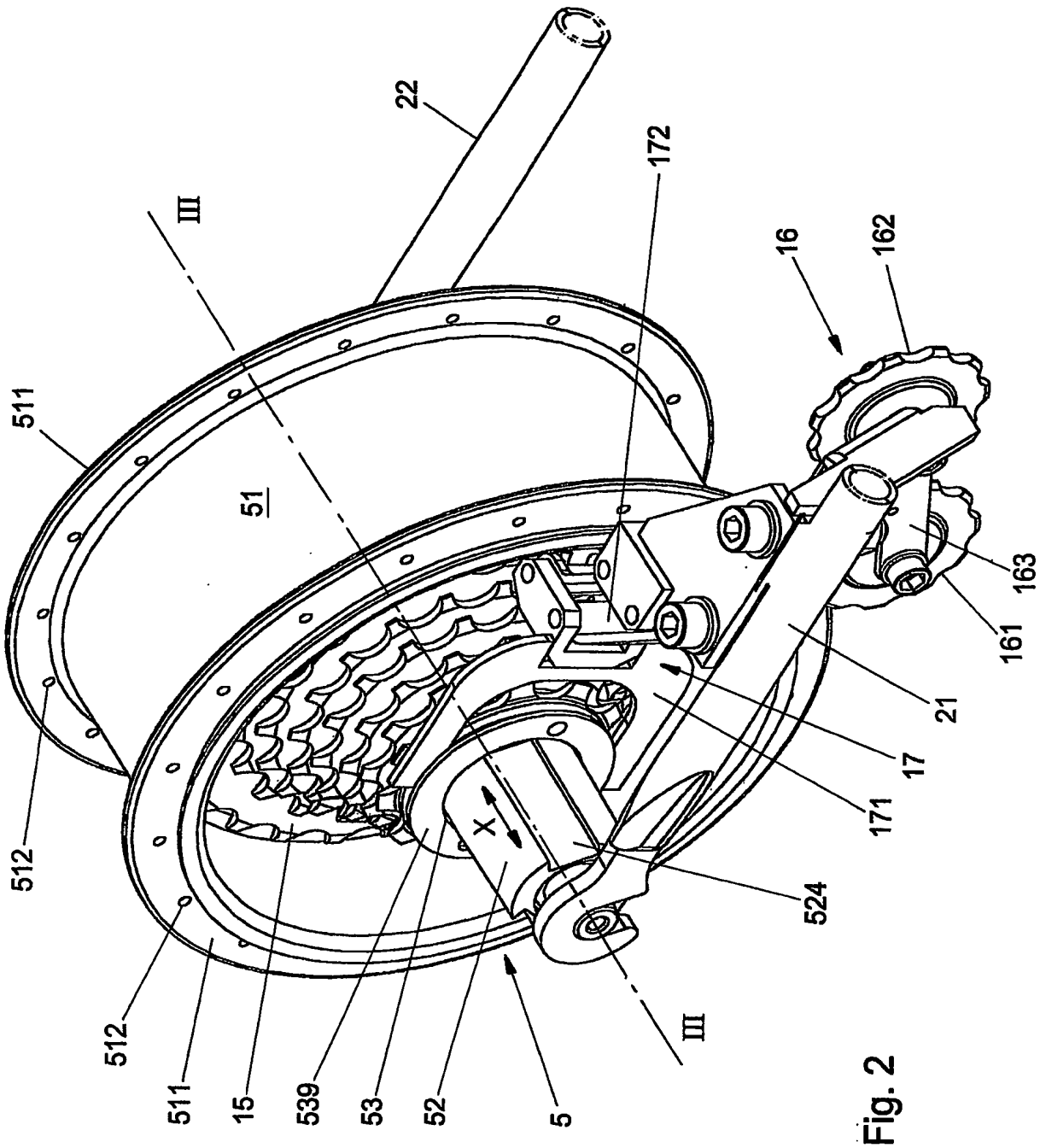

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Fig. 2

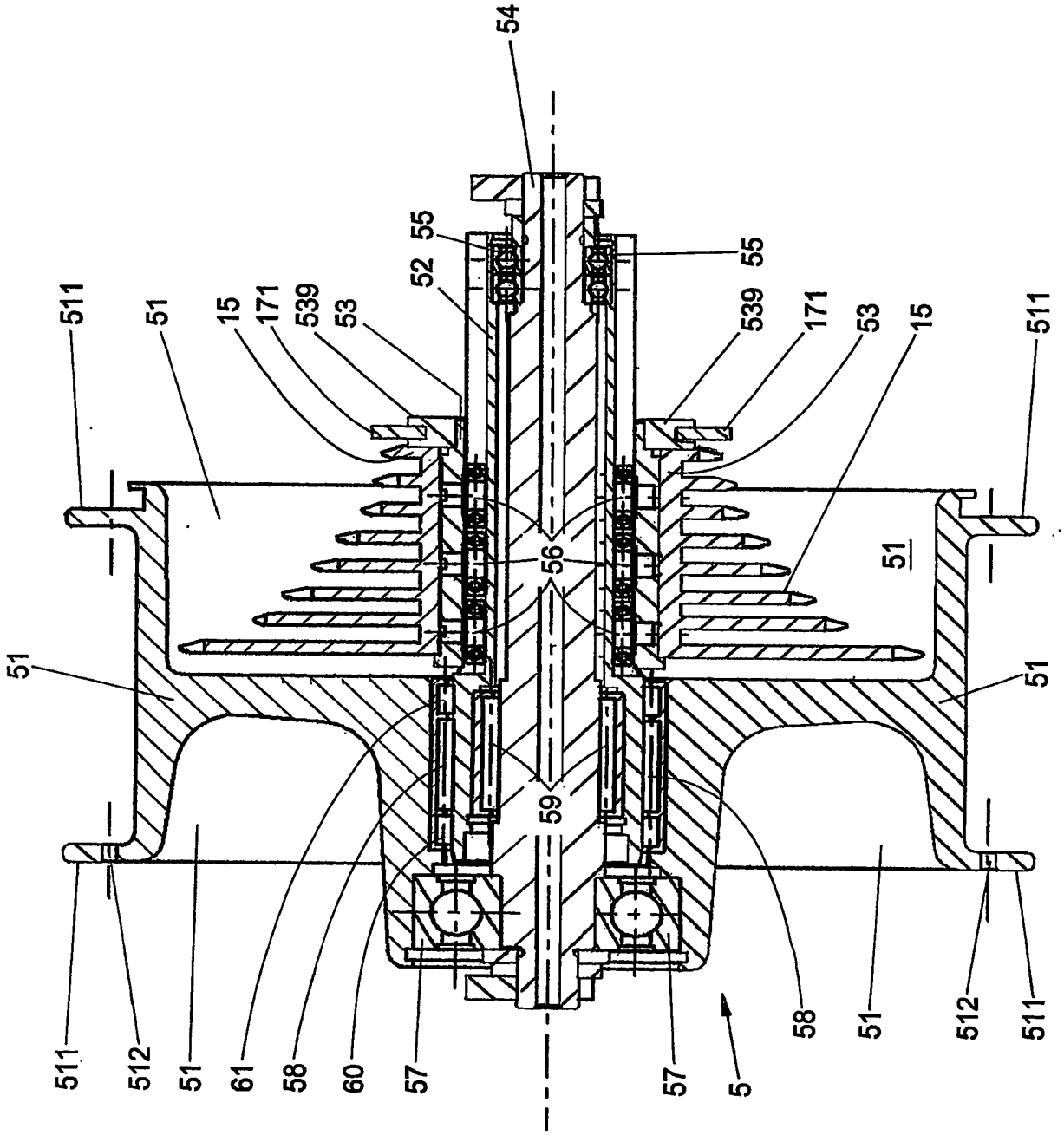

Fig. 3

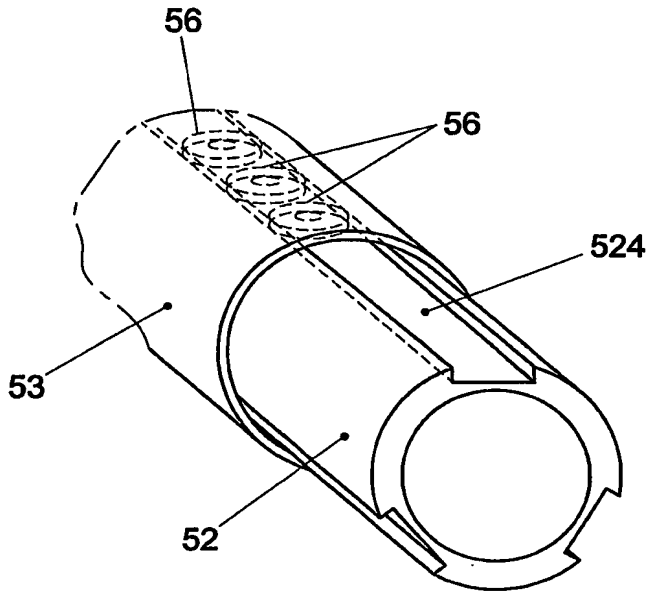

Fig. 4

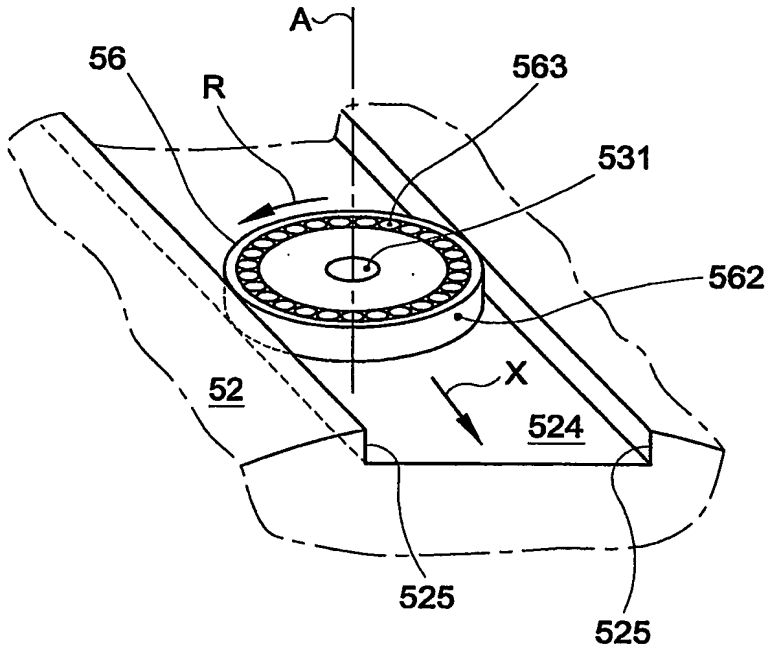
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Fig. 5

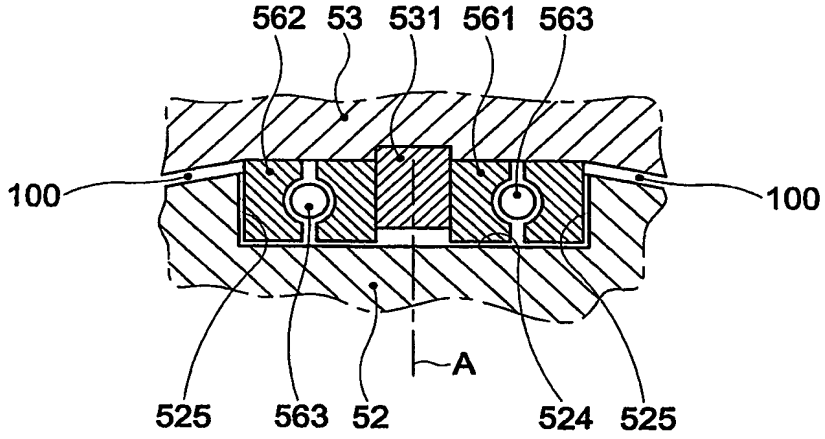
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Fig. 6

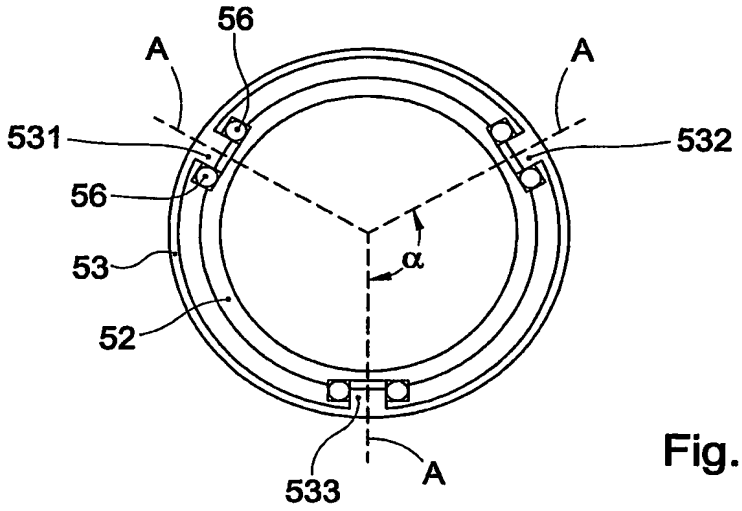

Fig. 7

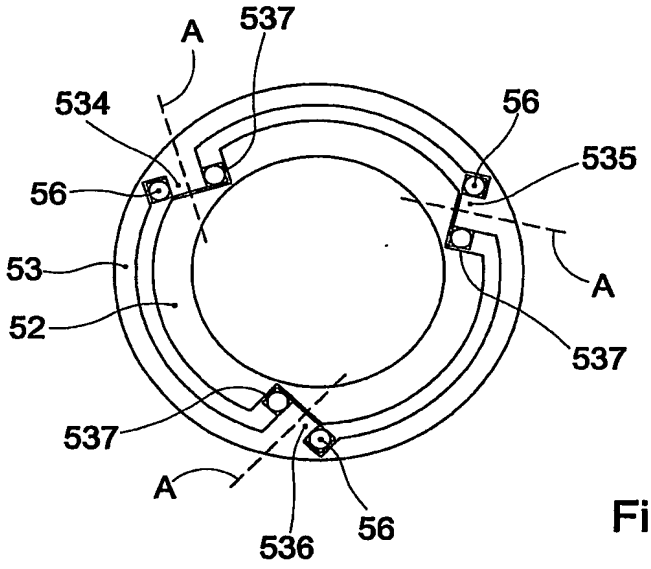

Fig. 8

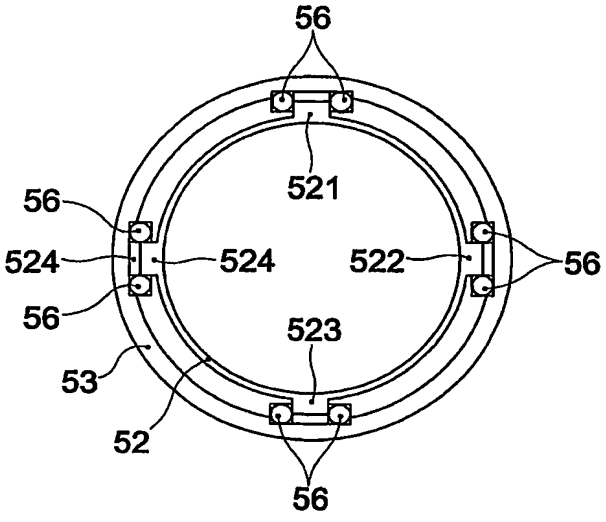

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NL 02/00081

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B62M 9/14
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B62M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 0068068 A1 (TUSHUIZEN ET AL), 16 November 2000 (16.11.00), page 6, line 16 - page 7, line 33, figures 1,3, abstract --	1-3,5-11
Y	FR 921278 A (M. ADOLPHE PEROY), 2 May 1947 (02.05.47), page 1, line 31 - line 48, figures 1,2 -- --------	1-3,5-11

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
30 Sept 2002	18. 10. 2002

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Information on patent family members

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International application No.
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